CLAIMS

1. A process for manufacturing a carbon fiber, comprising the steps of:

(1) spinning or forming a mixture of 100 parts by weight of a thermoplastic resin and 1 to 150 parts by weight of at least one thermoplastic carbon precursor selected from the group consisting of pitch, polyacrylonitrile, polycarbodiimide, polyimide, polybenzazole and aramide into a precursor fiber or a precursor film;

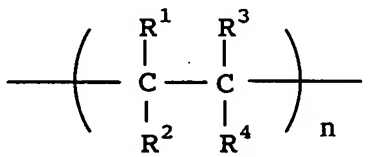
(2) subjecting the precursor fiber or film to a stabilization treatment to stabilize the thermoplastic carbon precursor contained in the precursor fiber or film so as to form a stabilized precursor fiber or film;

(3) removing the thermoplastic resin from the stabilized precursor fiber or film to form a fibrous carbon precursor; and

(4) carbonizing or graphitizing the fibrous carbon precursor to form a carbon fiber.

2. The process according to claim 1, wherein the thermoplastic resin has a free volume diameter at 20°C measured by a positron extinction method of 0.5 nm or more.

3. The process according to claim 1, wherein the thermoplastic resin is represented by the following formula (I):



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wherein R^1, R^2, R^3 and R^4 are each independently a hydrogen atom, alkyl group having 1 to 15 carbon atoms, cycloalkyl group having 5 to 10 carbon atoms, aryl group having 6 to

12 carbon atoms or aralkyl group having 7 to 12 carbon atoms, and n is an integer of 20 or more.

4. The process according to claim 1, wherein the thermoplastic resin is at least one selected from the group consisting of homopolymers and copolymers of 4-methylpentene-1 and homopolymers and copolymers of ethylene.

5. The process according to claim 1, wherein the pitch as a thermoplastic carbon precursor is meso-phase pitch.

6. The process according to claim 1, wherein the difference between the surface tension of the thermoplastic resin and the surface tension of the thermoplastic carbon precursor is 15 mN/m or less.

7. The process according to claim 1, wherein the average equivalent diameter of the thermoplastic carbon precursor on the section of the precursor fiber or film is 0.01 to 50 μm.

8. The process according to claim 1, wherein the mixture in the step (1) further contains 0.001 to 20 parts by weight of a polymer selected from the group consisting of (E) a copolymer of a polymer segment (e1) which satisfies the following expression (1) and a polymer segment (e2) which satisfies the following expression (2):

$0.7 < (\text{surface tension of polymer segment (e1)})/(\text{surface tension of thermoplastic carbon precursor}) < 1.3$ (1)

$0.7 < (\text{surface tension of polymer segment (e2)})/(\text{surface tension of thermoplastic resin}) < 1.3$ (2)

and (F) a homopolymer which satisfies the following expressions (3) and (4):

$0.7 < (\text{surface tension of homopolymer (F)})/(\text{surface tension of thermoplastic carbon precursor}) < 1.3$ (3)

$0.7 < (\text{surface tension of homopolymer (F)})/(\text{surface tension of thermoplastic resin}) < 1.3$ (4).

9. The process according to claim 8, wherein the polymer segment (e1) is a styrene homopolymer or copolymer.

10. The process according to claim 8, wherein the polymer segment (e2) is an ethylene homopolymer or copolymer.

11. The process according to claim 8, wherein the copolymer (E) is a graft copolymer or block copolymer.

12. The process according to claim 1, wherein the spinning and film formation of the step (1) are carried out by melt extrusion.

13. The process according to claim 12, wherein the melt extrusion is carried out at a temperature of 100 to 400° C.

14. The process according to claim 12, wherein the film formation is carried out by shearing at 1 to 100,000 S^{-1}.

15. The process according to claim 1, wherein a precursor fiber having an equivalent diameter of 1 to 100 μm or a precursor film having a thickness of 0.1 to 500 μm is formed in the step (1).

16. (cancelled)

17. The process according to claim 1, wherein the precursor fiber or film is stretched between the step (1) and the step (2).

18. The process according to claim 1, wherein the removal of the thermoplastic resin in the step (3) is carried out by thermally decomposing the thermoplastic resin at a temperature of 400 to 600° C to gasify it.

19. The process according to claim 1, wherein carbonization or graphitization in the step (4) is carried out at a temperature of 700 to 3,000° C in an inert atmosphere.

20. A process for manufacturing a carbon fiber mat, comprising the steps of:

(1) melt extruding a mixture of 100 parts by weight of a thermoplastic resin and 1 to 150 parts by weight of at least one thermoplastic carbon precursor selected from the group consisting of pitch, polyacrylonitrile, polycarbodiimide, polyimide, polybenzazole and aramide to form a precursor film;

(2) subjecting the precursor film to a stabilization treatment to stabilize the thermoplastic carbon precursor contained in the precursor film so as to form a stabilized precursor film;

(3) laminating together a plurality of the stabilized precursor films to form a stabilized precursor laminated film;

(4) removing the thermoplastic resin from the stabilized precursor laminated film to form a fibrous carbon precursor mat; and

(5) carbonizing or graphitizing the fibrous carbon precursor mat to form a carbon fiber mat.

21. A composition for producing fibrous carbon, comprising 100 parts by weight of a thermoplastic resin and 1 to 150 parts by weight of at least one thermoplastic carbon precursor selected from the group consisting of pitch, acrylonitrile, polycarbodiimide, polyimide, polybenzazole and aramide.

22. The composition according to claim 21 which further comprises 0.001 to 20 parts by weight of a polymer selected from the group consisting of (E) a copolymer of a polymer segment (e1) which satisfies the following expression (1) and a polymer segment (e2) which satisfies the following expression (2):

$0.7 < (\text{surface tension of polymer segment (e1)})/(\text{surface tension of thermoplastic carbon precursor}) < 1.3$ (1)

$0.7 < (\text{surface tension of polymer segment (e2)})/(\text{surface tension of thermoplastic resin}) < 1.3$ (2)

and (F) a homopolymer which satisfies the following expressions (3) and (4):

$0.7 < (\text{surface tension of homopolymer (F)})/(\text{surface tension of thermoplastic carbon precursor}) < 1.3$ (3)

$0.7 < (\text{surface tension of homopolymer (F)})/(\text{surface tension of thermoplastic resin}) < 1.3$ (4).

23. The composition according to claim 21 or 22 which is substantially composed of 100 parts by weight of the thermoplastic resin and 1 to 150 parts by weight of the thermoplastic carbon precursor, or of 100 parts by weight of the thermoplastic resin, 1 to 150 parts by weight of the thermoplastic carbon precursor and 0.001 to 20 parts by weight of the copolymer (E) and/or the homopolymer (F).

24. The composition according to claim 21, wherein the thermoplastic carbon precursor is dispersed in the

thermoplastic resin matrix in a particulate form and the average equivalent particle diameter of the dispersed thermoplastic carbon precursor is 0.01 to 50 μm.

25. The composition according to claim 21, wherein the average equivalent particle diameter of the dispersed thermoplastic carbon precursor after it is heated at 300°C for 3 minutes is 0.01 to 50 μm.

26. The composition according to claim 21 prepared by mixing together the thermoplastic resin and the thermoplastic carbon precursor at a temperature at which the melt viscosity of the thermoplastic resin becomes 0.5 to 30 times higher than the melt viscosity of the thermoplastic carbon precursor at a shear rate of 1,000 S^{-1}.

27. Use of the carbon fiber obtained by the process of claim 1 in an electrode for batteries.

28. Use of the carbon fiber obtained by the process of claim 1 to be mixed with a resin.

29. Use of the composition of claim 21 as a raw material for manufacturing a carbon fiber.